A CONTRIBUTION TO THE KNOWLEDGE OF THE MICROCOTYLIDAE OF WESTERN AUSTRALIA

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Introduction

The following is a list of the hosts and the respective parasites obtained from them:

Gerres ovatus Waite—*Microcotyle gerres* n. sp.
Pentapodus milii Bory St. Vinc.—*Microcotyle pentapodi* n. sp.
Scorpis aequipinnis Richdon.—*Microcotyle scorpis* n. sp.
Helotes sexlineatus Q. & G.—*Microcotyle helotes* n. sp.
Caranx georgianus Cuv. Val.—*Gonoplasius carangis* n. g., n. sp.
Agonostomus forsteri Cuv. Val.—*Diplasiocotyle johnstoni* n. g., n. sp.

The measurements (taken from specimens mounted in balsam) are the average for several parasites where possible, and those of the type specimen are given in brackets. The parasites were fixed in Kleinenberg's picric acid; acetic acid alum carmine was the commonly used stain, but cochineal alum carmine was also utilised. 70% alcohol saturated with chlorine gas was used as a destaining agent with both stains. Borax carmine was also used, followed by weak acid alcohol as the destaining agent.

Appreciation is expressed for the co-operation of the Government Fisheries Department, which has been very useful in this work, especially under the present conditions due to war-time restrictions. The writer would also like to express thanks to Professor G. E. Nicholls for his help and encouragement; to Miss O. Goss for guidance, and to Professor T. Harvey Johnston for assistance in preparing this paper for publication.

Microcotyle gerres n. sp.

(Fig. 1-3)

From the gills of the silverfish, silverbelly or roach, *Gerres ovatus,* from Mandurah. The gills of the host species were examined frequently during a period from the middle of February to the middle of June, 1943. The parasites were not numerous at any time, nor does there appear to be any period when their occurrence is more prevalent. The maximum taken from one fish was three. Of 52 fish examined only 15 had parasites, only one Microcotylid being present in most cases.

M. gerres is a small, elongated form, having a total length 2·43 mm. (2·35) and a maximum breadth of 0·36 mm. (0·37) across about the middle of the genital complex. Body tapering slightly towards both ends. Body width across region of oral sucker 0·14 mm.; across region of penis 0·20 mm. Cotylophore distinctly demarcated from rest of body; 1·07 mm. (0·98) long, hence about two-fifths of total body length. Fifty pairs of posterior suckers on cotylophore, varying in size from anterior to posterior; anterior having width of 0·038 mm. (0·037), those at about the middle length 0·058 mm. (0·062), and those posteriorly 0·042 mm. (0·050); the length in each case being 0·025 mm. (fig. 3).

Oral suckers approximately circular, 0·063 mm. diameter, without transverse septa. Three groups of "sticky" glands near mouth and anterior to oral suckers (fig. 1). Buccal cavity large; pharynx circular 0·037 mm. diameter; oesophagus 0·125 mm. long with lateral diverticula and dividing just in front of penis, at 0·20 mm. from anterior end of body; intestinal canals with numerous lateral diverticula and extending 0·63 mm. into cotylophore (fig. 1).

Brain rectangular, at 0·13 mm. from head end; a pair of small nerves passing forwards from its anterior corners; a pair of longitudinal nerves and a pair of smaller nerves given off posteriorly (fig. 1).

Sixteen testes, subcircular, average diameter 0·375 mm., occupying intervitelline field 0·63 mm. long, approximately the posterior half of body anterior to cotylophore; several of most anterior lying beside part of main genital complex. Vas deferens, wide, running from anterior end of testicular field in an almost straight course to penis; anterior end of latter 0·187 mm. from anterior end of body (fig. 1). This Microcotylid is peculiar in that it possesses no genital armature, there being merely a chitinous penis, which, when extended, has a length of 0·046 mm. (0·037) (fig. 2).

Ovary median, differing from the typical ovary in that it begins on the left side of the intervitelline field about half-way up the genital complex, and curves over to the right, the oviduct then passing posteriorly to be joined by the common vitelline duct. Vitellarium arising 0·24 mm. from anterior end of body, occupying two lateral fields which join behind testicular field and extend 0·65 mm. (0·63) into cotylophore. Vitelline ducts arising laterally at unequal distances from anterior end; left and right ducts leaving vitellarium at 0·96 mm. and 0·88 mm. respectively from anterior end of worm; common vitelline duct passing posteriorly for 0·04 mm. to unite with oviduct; genito-intestinal canal passing to the left. Uterus thin-walled, straight, dorsal, passing forwards to open by pore at anterior end of penis (fig. 1).

M. gerres appears to be a rather distinct form, bearing perhaps the closest resemblance to *M. sillaginae* Woolcock (1936) and *M. parasillaginae* Sandars (1944). There are, however, many outstanding differences between these forms, as shown in the table (measurements in mm.).

TABLE I

	Total Body Length	Length of Cotylophore	Pairs and Size of Posterior Suckers	Size of Oral Suckers	Oral Suckers with or without Septa	No. of Testes	Length of Penis	Genital Atrium Armature	Relation of Intestinal Bifurcation to Atrium
M. gerres ..	2·43	1·07 Ca. $\frac{2}{5}$ Body length	50; Vary.: Ant. 0·038, Mid. 0·058, Post. 0·042	0·063 Diam.	Without	16	·046	Absent	Anterior
M. sillaginae ..	4·0	Half-length or more	32; ·05–·07 wide	·08 x ·04	With	11	·027, plus Papilla	Absent	Anterior
M. parasillaginae	2·15	Ca. $\frac{1}{3}$ length	25–27; Constant ·064	·08 x ·048	With	14	·048, No Papilla	Present	Posterior

Microcotyle pentapodi n. sp.

(Fig. 4-7)

From the gills of the butterfish, *Pentapodus milii,* from Rockingham. The gills of several hosts were examined during January 1943, and all were heavily infected with Microcotylids. Examination from 23 to 26 April 1943 showed the fish to be infected, 0–5 parasites being obtained from each fish. No systematic investigation could be carried out, but examinations indicated the Microcotylids as being more numerous during summer months and decreasing in April.

M. pentapodi is a small, elongated, slender form, 2·06 mm. (2·14) long; maximum width 0·25 mm. at approximately half-way along the body proper; body tapering towards both ends; body width 0·2 mm. at level of genital armature;

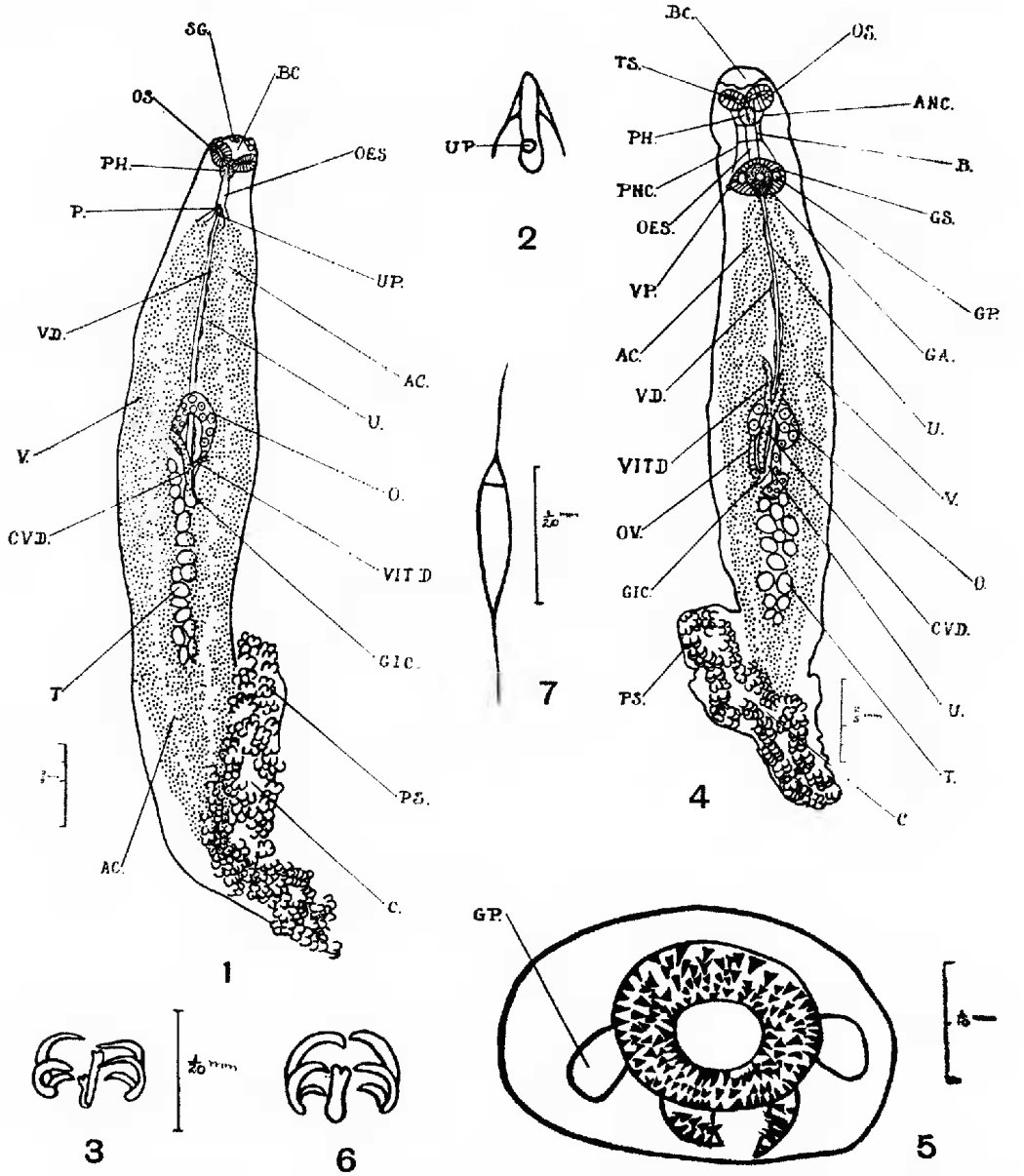

Fig. 1-7—1-3, *Microcotyle gerres:* 1, whole specimen; 2, penis; 3, skeleton of posterior sucker. 4-7, *Microcotyle pentapodi:* 4, whole specimen; 5, genital armature; 6, skeleton of posterior sucker; 7, egg.

0·16 mm. across oral suckers. Cotylophore sharply demarcated from rest of body, 0·623 mm. (0·617) long, anterior border 0·04 mm. (0·05) wide, 0·023 mm. (0·016) long (fig. 6).

Oral suckers with transverse septa; width 0·063 mm. (0·066); length 0·052 mm. (0·05). Buccal cavity large, opening anteriorly; pharynx 0·033 mm. wide, 0·05 mm. long; oesophagus passing anteriorly for 0·22 mm., then bifurcating immediately behind genital sucker, uniting again in cotylophore and extending into it for 0·25 mm.; lateral diverticula present (fig. 4).

Fifteen circular testes in intervitelline field; latter approximately one-fifth of body length, 0·059 mm. (0·066) diameter in middle of testicular field, 0·046 mm. (0·05) diameter at both ends. Vas deferens thick-walled, wide, passing anteriorly and medially in a sinuous course to genital atrium 0·24 mm. from head end of worm. Atrium unusual in being completely surrounded by a large sucker (genital sucker), 0·125 mm. (0·15) maximum width, 0·1 mm. maximum length. Atrial hooks approximately central in atrium and forming complete circlet, 0·06 mm. wide, 0·05 mm. long, 0·24 mm. (0·25) from anterior end of body. Two curved rows of hooks arranged lengthwise occur posteriorly to this. All hooks extremely small. Atrial cavity with two lateral pockets, diameter approximately 0·025 mm., outside the armature of spines (fig. 5).

Median ovary arising near anterior testes and passing forwards to form enlarged broad curved portion, thence transversely and backwards. Vitellarium commences 0·35 mm. (0·38) from anterior end of body, uniting behind testicular field and extending 0·32 mm. (0·28) into cotylophore. Paired vitelline ducts 0·16 mm. long, originating 0·83 mm. from head end, uniting as common vitelline duct 0·15 mm. long, joined by oviduct; genito-intestinal canal, passing to left. Uterus thin-walled, straight, opening into genital atrium between two curved rows of hooks, posterior to vas deferens. Posteriorly to left of genital pore, 0·3 mm. from anterior end of worm, a single pore (probably vaginal) opens (fig. 4).

Egg single, oval, with appendage 0·15 mm. at each end, observed in uterus; egg length (excluding appendages) 0·2 mm., width 0·05 mm. (fig. 7).

M. pentapodi appears to be related to *M. ditrematis*, which Yamaguti (1939) related to *M. incisor* Linton (1910). It differs from *M. ditrematis* in the genital atrium, which, although apparently of a related type in both, shows obvious differences. Both bear saccular outgrowths; in *M. ditrematis* single and armed; in *M. pentapodi*, paired and unarmed. It also shows some resemblances in general structure to the group *M. elegans* and *M. sebastis* Goto (1895), *M. hiatulae* Goto (1899), *M. australiensis* MacCallum (1921), *M. bassensis* Murray (1931),

ABBREVIATIONS

AC, alimentary canal; AGS, anterior glandular structure; ALH, anterior large hooks; ANC, anterior nerve cord; ANT, anterior; B, brain; BC, buccal cavity; C, cotylophore; CI′, cilia of 1st region of body of larva; CI″, cilia of 2nd region of body of larva; CI‴, cilia of 3rd region of body of larva; CVD, common vitelline duct; DGS, duct connecting glandular structures; DS, dorsal sucker; E, egg; E′, eyespot; EC, excretory canal; EP, excretory pore; EV, excretory vesicle; GA, genital atrium; GC, genital complex; GD, genital duct, GH, genital hooks; GIC, genito-intestinal canal; GP, genital pockets of atrium; GS, genital sucker; H, hooks; I, intestine; M, mouth (fig. 25-30 miracidium); MB, muscular base; O, ovary; O′, developing ovary; OES, oesophagus; OS, oral sucker; OSH, hooks of oral sucker; OV, oviduct; P, penis; PGS, posterior glandular structure; PH, pharynx; PNC, posterior nerve cord; PS, posterior sucker; RS, receptaculum seminis; SH, small hooks; SO, shell gland and ootype; SPS, small posterior sucker; T, testes; T′, tail; TS, transverse septum; U, uterus; UP, uterine pore; V, vitellarium; VC, vaginal canal; VD, vas deferens; VITD, vitelline duct; VP, vaginal pore.

M. temnodontis Sandars (1944). These vary in structure of the genital atrium. Other differences shown in the table (measurements in mm.).

TABLE II

	Total Length	Length of Cotylophore	Pairs and Size of Posterior Suckers	Oral Suckers, With or Without Septa	Genital Atrium With or Without Sucker	No. of Testes	Vitellarium extends into Cotylophore
M. pentapodi ..	2.06	0.62	24–25; .04 x .023	With	With	15	0.32
M. ditrematis ..	3.4–4.5	1.2–2.1	39–44; .06–.08	With	Without	22–25	Almost to Post. End
M. temnodontis ..	2.72	0.72	55; .016 x .32	Without	Without	21	0.08
M. australiensis ..	4.0	1.4	Numerous; ?	?	Without	25	?
M. sebastis	5.50	1.83	29; .068–.128	With	Without	40	Nil
M. elegans	4.0	1.3	50; .04–.068	With	Without	27	?
M. victoriae ..	4.82	Ca. 1.2	21; ?	With	Without	18–22	?
M. hiatulae	3.5		23; ?	?	Without	15	Nil

Microcotyle scorpis n. sp.

(Fig. 8-10)

From the gills of the sweep, *Scorpis aequipinnis,* from Safety Bay. In January 1943, from the gills of the only sweep examined, six Microcotylids were collected. No further specimens could be obtained, hence no systematic examination could be made.

M. scorpis is a broad, compact form of total length 2·67 mm. (2·68), maximum breadth (at level of ovarian curve) 0·66 mm. Body tapering anteriorly to 0·38 mm. from front of body, then narrowing conspicuously. Body width across genital armature 0·22 mm.; across oral suckers 0·20 mm. Body not tapering posteriorly; cotylophore not distinctly separated (fig. 8). Cotylophore of total length 0·83 mm. (0·81); width across anterior border 0·63 mm., across posterior border 0·09 mm. Twenty suckers along left border of cotylophore which is 0·63 mm. long, 34 along right border which is 0·94 mm. Each sucker 0·037 mm. long, 0·062 mm. (0·05) wide (fig. 10).

Oral suckers, without transverse septa, maximum width 0·07 mm. (0·075), length 0·062 mm. Mouth aperture at anterior end. Circular muscular pharynx, diameter 0·037 mm., leading into oesophagus 0·125 mm. long; latter bifurcating immediately anterior to region of genital atrium; latter 0·24 mm. from anterior end of body. Intestinal canals with numerous lateral diverticula and extending 0·5 mm. into cotylophore, but left arm 0·13 mm. longer than right arm (fig. 8). Anterior portion of both longitudinal excretory ducts run along either side of body (fig. 8).

Brain complex rectangular, dorsal to oesophagus, at 0·13 mm. from anterior of body; one pair of nerves passing forwards, another pair backwards (fig. 8).

Testes 32, irregularly shaped, varying in size from 0.112 mm. wide by 0·025 mm. long, to 0·212 mm. wide by 0·05 mm. long, close together, occupying approximately one-third of total body length posteriorly. Vas deferens thick-walled, fairly wide, winding anteriorly, opening into ventral genital atrium; latter 0·275 mm. from anterior end of body and with an armature of conical hooks curving inwards, length 0·012 mm. Genital armature arranged ovally, maximum width 0·037 mm., maximum length 0·025 mm.

Ovary, maximum length 0·35 mm. median, arising in front of anterior testes, passing forwards to left, bending to right, curving to pass backwards and then joined by common vitelline duct. Vitellarium commencing 0·40 mm. from anterior end of body, occupying both lateral fields, extending 0·44 mm. (0·41) into cotylophore where the two arms join behind the testes. Left vitelline duct arising 0·69 mm. from anterior of body, right 0·56 mm.; left passing 0·38 mm. posteriorly, right 0·50 mm., before joining to form common vitelline duct with length 0·23 mm.; genito-intestinal canal passing to right. Uterus thin-walled, passing posteriorly, then curving forwards to genital atrium (fig. 8).

M. scorpis appears to be most closely related to *M. seriolae* Yamaguti (1939) and *M. reticulata* Goto (1895), the most obvious feature in common being the asymmetry of the cotylophore, whose suckers are in each case more numerous on the right side. The general anatomy of these forms seems to be similar; that of *M. scorpis* most resembling *M. seriolae*. Many differences are shown in the table.

TABLE III

	Total Body Length	Length of Cotylophore	No. of Posterior Suckers	Av. Size of Suckers of Cotylophore	Oral Suckers with or without Septa	Size of Oral Suckers	No. and Form of Testes	Genital Atrium Armature
M. scorpis	2·68	0·83	34 right, 20 left	0·037 long, ·062 wide	Without	0·062 long, x 0·07 wide	32, irregular	Present
M. seriolae	4·1–8·5	1·75–3·5	Right 45–47, left 39–42	0·036–·12 wide	?	0·060–·075 x ·080–·093	80–100, irregular	Absent
M. reticulata ..	6–10	Little more than $\frac{1}{3}$ Body length	Right 42, left 23	0·075–·227 wide	Without	?	Numerous, rounded ?	Present

Microcotyle helotes n. sp.

(Fig. 11-14)

From gills of the trumpeter, *Helotes sexlineatus*, from Swan River, at Nedlands, Rockingham, Safety Bay. During January 1943 the gills of several hosts were examined and Microcotylids found. From two from Swan River, in mid-

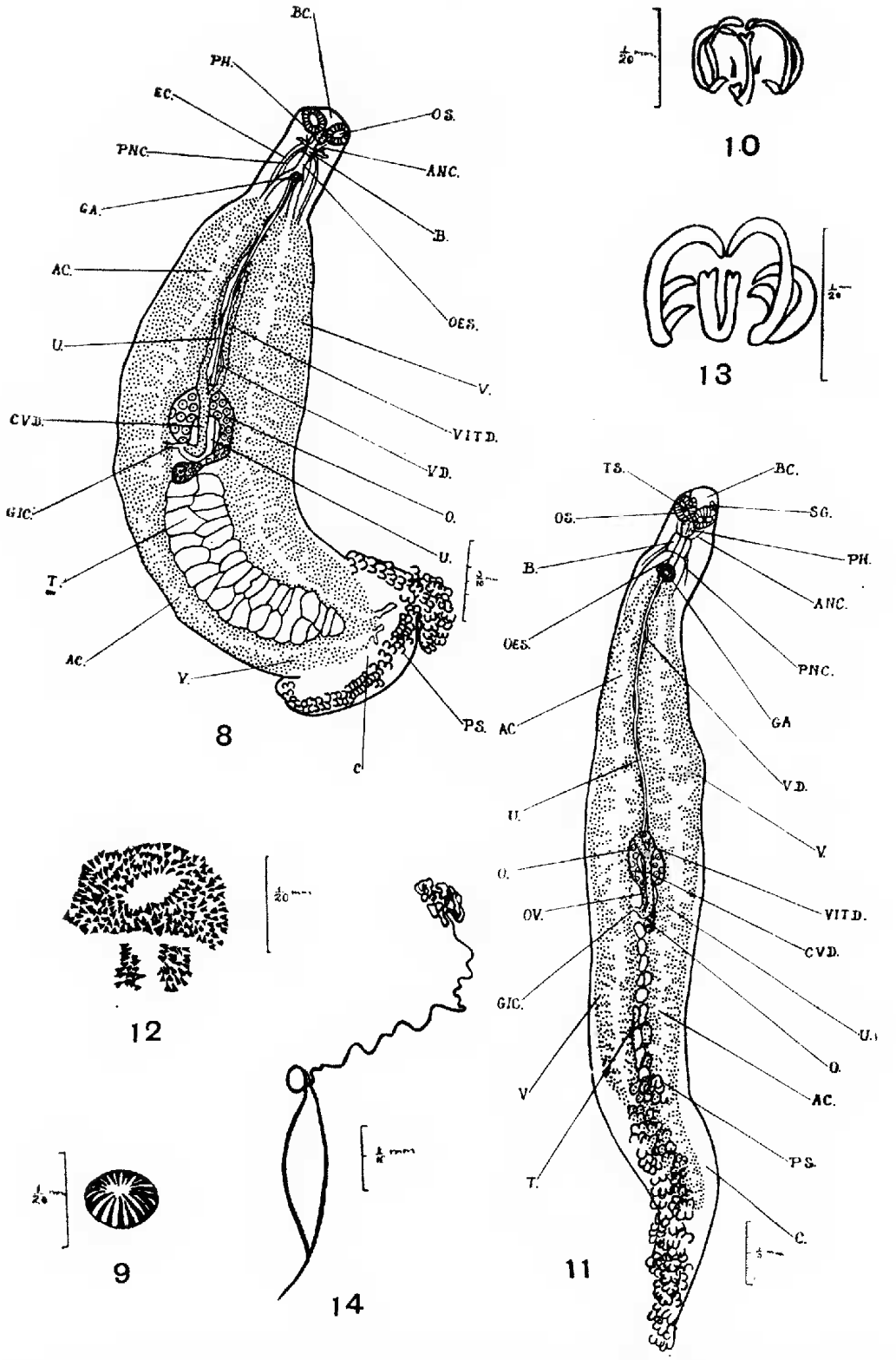

Fig. 8-14—8-10, *Microcotyle scorpis:* 8, whole specimen; 9, genital armature; 10, skeleton of posterior sucker. 11-14, *Microcotyle helotes:* 11, whole specimen; 12, genital armature; 13, skeleton of posterior sucker; 14, egg.

March, 1 and 11 parasites respectively were collected. Of 23 fish from Safety Bay, in early May, two had each one parasite, three had each two.

M. helotes is a medium-sized, elongated form of total length 2·87 mm. (2·69); maximum width (just anterior to commencement of paired vitelline ducts) 0·38 mm. Body tapering anteriorly and posteriorly. Width across oral suckers 0·14 mm.; across genital atrium 0·2 mm. Cotylophore not distinctly demarcated from rest of body; 1·02 mm. (0·81) long; with 32 pairs of suckers, each 0·058 mm. (0·037) wide; 0·033 mm. (0·037) long (fig. 13).

Oral suckers, 0·059 mm. (0·052) wide, 0·071 mm. (0·075) long, with transverse septa. Three groups of "sticky" glands anterior to oral suckers (fig. 11). Buccal cavity opening anteriorly; pharynx circular, diameter 0·038 mm. Straight oesophagus passes 1·187 mm. backwards, dividing shortly behind genital armature, 0·31 mm. from the anterior of body. The two longitudinal arms with numerous diverticula, extending 0·46 mm. into the cotylophore. Brain rectangular, 0·15 mm. from head end; dorsal to oesophagus; one pair of nerves passing anteriorly, two pairs posteriorly (fig. 11).

Fourteen irregular testes approximately 0·05 mm. by 0·054 mm. (0·037), in an intervitelline field 0·625 mm. long, hence one-quarter of body length; most anterior testes extending forwards, laterally to main genital complex. Genital armature of numerous minute hooks; of maximum width 0·087 mm. (0·087), maximum length 0·07 mm. (0·063) situated 0·24 mm. (0·25) from anterior end of body (fig. 12).

Ovary, maximum length 0·3 mm., passing forwards to left, then swinging to right by an enlarged region, then passing backwards to become joined by common vitelline duct. Vitellarium begins 0·34 mm. from anterior of body, occupying both lateral fields, extending into the cotylophore 0·51 mm. (0·46), uniting behind testicular field. Paired vitelline ducts arising laterally 1·06 mm. from anterior end of body, passing posteriorly for 0·06 mm., then joining to form common vitelline duct, 0·175 mm. long; genito-intestinal canal passing to left. Uterus thin-walled, median (fig. 11). Egg seen in uterus only; anterior appendage over 1 mm., posterior 0·06 mm.; body of egg 0·225 mm. long, 0·062 mm. wide (fig. 14).

M. helotes appears to have closest affinities with *M. acanthogobii* Yamaguti (1939). In both the body is fusiform, and the cotylophore is not sharply demarcated from the rest of the body. In *M. acanthogobii* it commences at the level of the posterior testes; in *M. helotes* it begins just anterior to the latter. Testes of both species are of like shape, and are similarly arranged. Major differences are tabulated (measurements in mm.).

TABLE IV

	Total Body Length	Length of Cotylophore	Pairs of Posterior Suckers	Size of Suckers of Cotylophore	Oral Suckers with or without Septa	Size of Pharynx	No. of Testes	Size of Body of Egg
M. helotes	2·87	1·02	32	0·033 x 0·058	With	0·038 diam.	14	0·255 x 0·062
M. acanthogobii .	1·55–3·05	0·62–1·2	20–25	0·08 diam.	With	0·030–·048 x ·036–·054	7–12	0·18–·20 x 0·066–·075

Gonoplasius carangis n. g., n. sp.

(Fig. 15-19)

From gills of the skipjack, *Caranx georgianus,* from North Beach, Rockingham. From 24 fish examined between mid-February and mid-July 1943, five parasites were obtained, two from one host, one from each of three others. No parasites were obtained from *Caranx* caught at Mandurah, Bunbury, Augusta and Albany.

G. carangis is a very elongated, narrow form of total body length 4·75 mm.; maximum width of body (anterior to cotylophore) 0·4 mm. in region of genital complex where ovary curves from one side to other; this width continuing forwards for 0·625 mm., then tapering very gradually both anteriorly and posteriorly; width at level of genital armature 0·337 mm.; across oral suckers 0·275 mm. Cotylophore 0·75 mm. long, approximately one-sixth total body length, sharply demarcated from rest of body by increase in width. Anterior border of cotylophore 0·525 mm. wide, posterior border 0·037 mm. Cotylophore with unequal lateral borders; right 0·112 mm. long, bearing 34 small suckers; left 0·56 mm., bearing 17 small suckers, each with characteristic framework (fig. 18); constant length 0·037 mm.; width of anterior suckers 0·062 mm.; middle suckers 0·075 mm.; posterior 0·05 mm. At anterior end of body five conspicuous glandular structures, four large, one small; of three around buccal cavity two are large with maximum width 0·125 mm., length 0·037 mm.; most anterior central glandular structure 0·05 mm. wide, 0·037 mm. long. Close to oesophagus, at 0·162 mm. from anterior of body, two more glandular structures, left with maximum width 0·075 mm., length 0·1 mm.; right with maximum width 0·087 mm., length 0·1 mm. From each, running anteriorly, are two ducts; the inner branches 0·062 mm. from anterior of body, the outside branch in each case going to one of the large anterior structures and the inner to smaller central structure. Each anterior structure has two branches from two posterior groups (fig. 16).

Laterally and dorsally, 1·01 mm. from anterior of body are two pairs of structures of unknown function, appearing as apertures with edges set with minute hooks in a slightly muscular structure (fig. 19). These may be remnants of dorsal suckers in process of disintegration, since *Microcotyle agonostomi, M. canthari, M. alcedinis,* and *M. centrodontis* have small similarly situated suckers.

Buccal cavity at extreme anterior end of body, containing oral suckers with maximum width 0·15 mm., length 0·062 mm., and with transverse septa. Pharynx close to oral suckers, length 0·05 mm., width 0·037 mm. Oesophagus unbranched, total length 0·31 mm. Intestinal bifurcation about middle of genital atrium. Two longitudinal ducts in lateral fields of body have numerous lateral branches, and extend into cotylophore, 0·31 mm. on right and 0·15 mm. on left, beyond vitellarium. At 0·875 mm. from anterior end of body in mid-ventral line, 0·25 mm. posterior to genital atrium, is excretory vesicle, a nearly globular structure with maximum width 0·05 mm., length 0·037 mm. Paired lateral longitudinal ducts connect with vesicle (fig. 15).

Testes 48, rounded, 0·025-0·05 mm. diameter, occupying about one-fifth of total body length in an intervitelline field; vasa efferentia clearly seen between many of the testes; winding vas deferens passing anteriorly centrally; very coiled between excretory vesicle and genital atrium (fig. 15). Genital atrium with complex armature on ventral body surface, 0·387 mm. from anterior end of body; armature of small and large hooks, some set in a muscular base at anterior and posterior ends of atrium and of varying shapes; small hooks distributed between these; large anterior hooks 0·037 mm. long; largest posterior hooks 0·025 mm. long; small

hooks in central groups 0·012 mm. Width of anterior part of atrium (with armature) 0·137 mm.; of middle part 0·075 mm.; of posterior 0·125 mm.; maximum length of genital atrium with armature 0·237 mm. (fig. 17).

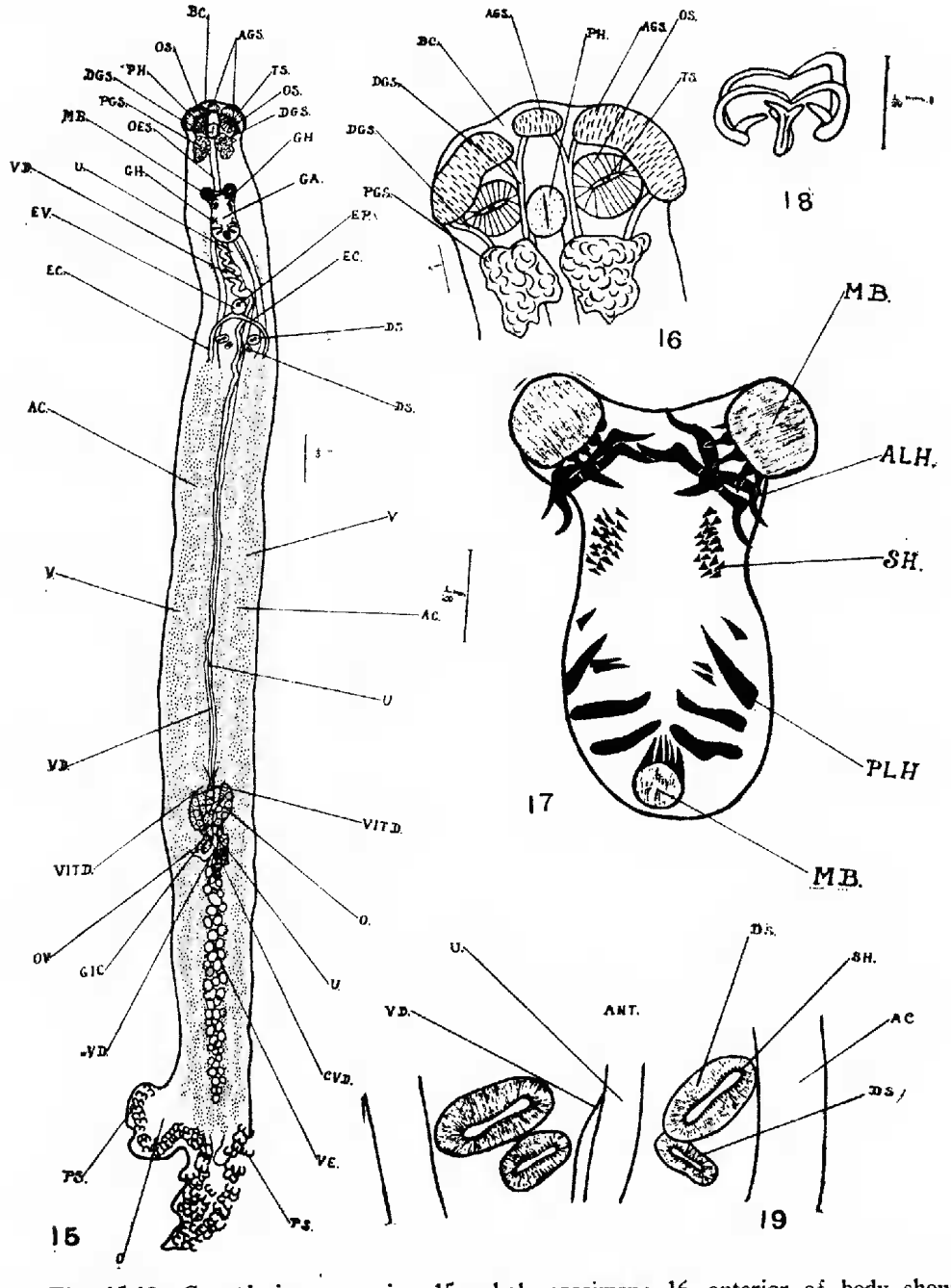

Fig. 15-19—*Gonoplasius carangis:* 15, whole specimen; 16, anterior of body showing glandular structures; 17, genital armature; 18, skeleton of one posterior sucker; 19, structure, probably dorsal suckers.

Conspicuous ovary at anterior end of posterior half of body, beginning immediately anterior to the testicular field, from which it winds to the right and at 2·62 mm. from anterior end of body, then curves to left and passes posteriorly on

right. Ovary, maximum length 0·412 mm., maximum width 0·062 mm. Two lateral fields of vitellarium commencing 0·587 mm. from anterior end of body, quite distinct anteriorly and posteriorly; posteriorly left arm extending 0·235 mm. into cotylophore; right 0·037 mm. Paired vitelline ducts arising from lateral fields 2·625 mm. from anterior end of body; base of each with enlargement, probably vitelline reservoirs; ducts then passing 0·012 mm. posteriorly to unite as common vitelline duct, 0·187 mm. long and joining oviduct. Genito-intestinal canal entering right intestinal arm. Uterus straight, thin-walled, opening apparently posterior to male pore.

GENERIC DIAGNOSIS: **Gonoplasius** n. g. Microcotylidae—Body very elongated, narrow; symmetrical except for the cotylophore. Latter comparatively short, sides unequal in length, longer side with a greater number of small suckers. Genital atrium large, armed with small and large hooks, some of the latter being embedded in a muscular base. Several groups of large glands associated with buccal cavity. Excretory system with terminal vesicle, median, dorsal, posterior to genital atrium.

Gonoplasius bears a very strong resemblance to *Microcotyle* Beneden and Hesse, but differs in several features. One of the most conspicuous differences is the presence in the former of the groups of anterior glandular structures, some around the buccal cavity and the rest near the oesophagus. *Gonoplasius* has a completely different and much more elaborate genital armature than that of *Microcotyle*. Goto (1897) stated regarding the excretory system, "in *Microcotyle* there is no distinct terminal sac, the vessel presenting just a perceptible enlargement before it opens to the exterior." Also in *Microcotyle* the excretory opening appears to be always on the same level as the genital armature or anterior to it. In *Gonoplasius* there is a very conspicuous excretory vesicle posterior to the genital atrium, opening medially and dorsally.

Diplasiocotyle johnstoni n. g., n. sp.

(Fig. 20)

From gills of the yellow-eyed mullet or pilchard, *Agonostomus forsteri*, from Mandurah and Bunbury. From the middle of February to the middle of August 1943, gills of 146 of these fish were examined, 185 parasites being obtained, there being usually only one parasite per fish until the middle of May. After that date they were very numerous, especially in June, when on one occasion 21 parasites were taken from one fish; the average at that period being three parasites per fish.

D. johnstoni is a large form, of total length 5·96 mm. (6·47); maximum body with 0·83 mm. (0·937) across region anterior to testicular field; body tapering anteriorly and posteriorly; body width across oral suckers 0·25 mm.; across genital atrium 0·287 mm. Cotylophore 1·77 mm. (1·94) long, hence occupying approximately one-third total body length; anterior margin 1·25 mm. long, posterior margin 0·562 mm. Seven large long-stalked suckers along each margin of cotylophore; one pair of minute suckers at extreme posterior end of cotylophore. Former of varying sizes; most anterior pair 0·425 mm. wide, 0·312 mm. long; middle pair 0·437 mm. wide, 0·312 mm. long; penultimate pair 0·375 mm. wide, 0·25 mm. long; last pair 0·25 mm. wide, 0·187 mm. long. All suckers with characteristic skeleton of a median hollow piece, with solid piece attached at one end to form U-shape; on either side two more pieces, one arm of which moves in the other which is slightly hollow (fig. 22). The pair of minute suckers 0·062 mm. wide, 0·044 mm. (0·05) long, have skeletons much as above, except that the lateral pieces are comparatively longer (fig. 23). A pair of small, simple, dorsal, lateral suckers of 0·075 mm. diameter at 1·125 mm. from anterior side of body.

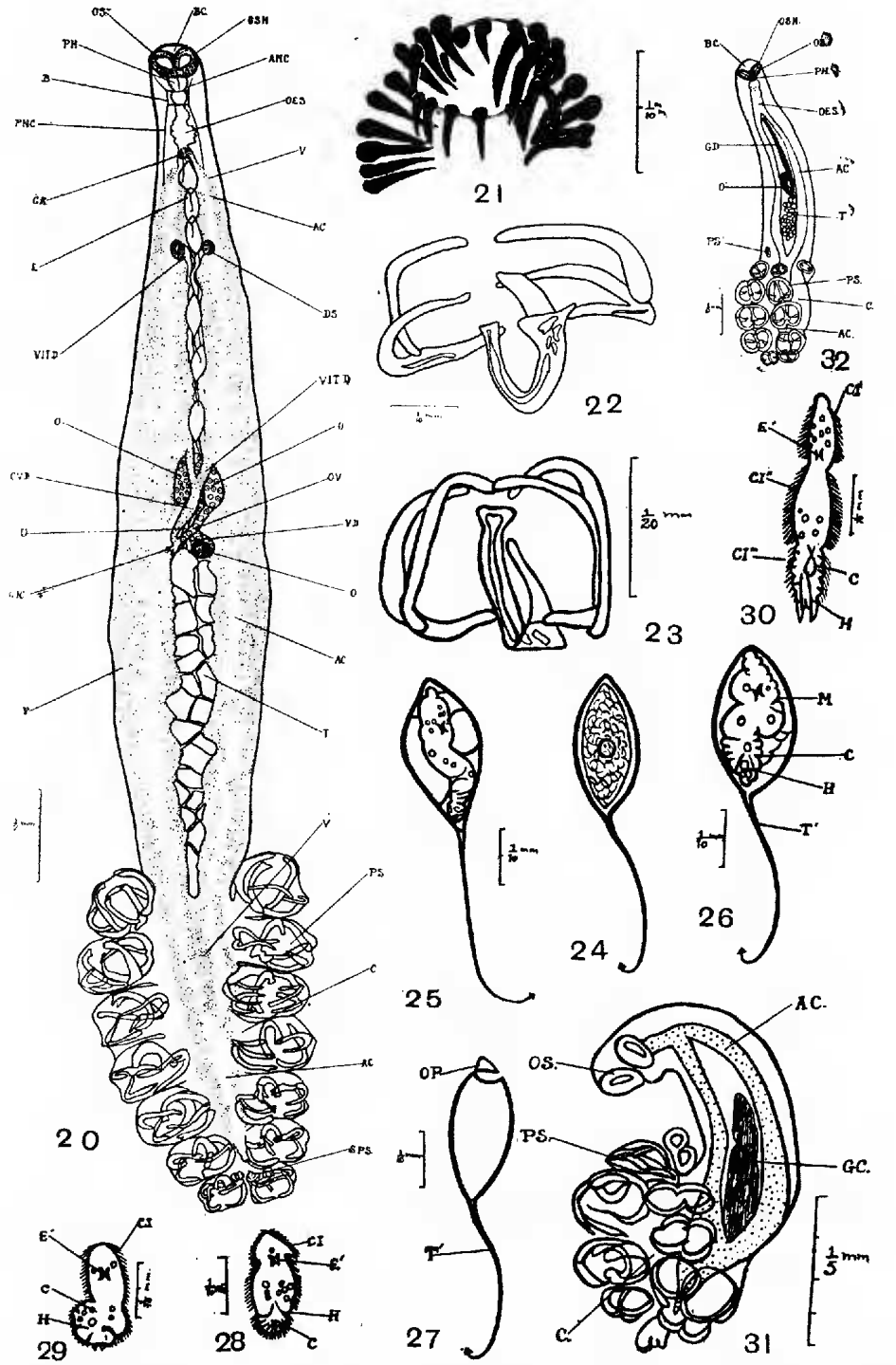

Fig. 20-32—*Diplasiocotyle johnstoni:* 20, whole specimen; 21, genital armature; 22, skeleton of large posterior sucker; 23, skeleton of small posterior sucker; 24, egg; 25 and 26, egg showing developing miracidium; 27, egg after miracidium has escaped; 28 and 29, miracidium; 30, miracidium elongated (28, 29, 30 to same scale = ·1 mm.); 31, very immature specimen; 32, immature specimen (scale = ·2 mm.).

Buccal cavity with subterminal aperture, with pair of conspicuous oral suckers, without septa, 0·137 mm. wide, 0·109 mm. (0·125) long, with inner margins set with small hooks. Pharynx, close to oral suckers, diameter 0·10 mm. Oesophagus 0·375 mm. long with numerous lateral diverticula. Intestinal bifurcation dorsal to genital atrium; two main longitudinal ducts along each side of body with numerous lateral diverticula, uniting behind testicular field; in cotylophore forming common canal 0·875 mm. long. Alimentary canal extending total distance of 1·624 mm. into cotylophore.

Twenty-two sub-quadrangular testes, all closely applied together in an intervitelline field, occupying approximately one-quarter total body length. Testes varying from 0·10 to 0·212 mm. in width, 0·075 to 0·25 mm. in length. Vas deferens passes anteriorly to genital atrium (fig. 20). Genital atrium 0·525 mm. from anterior end of body, armed with hooks constantly 0·013 mm. long; one central circlet of 15 hooks and on either side of this a semi-circle each with nine and seven hooks respectively (fig. 21).

Conspicuous ovary, shaped like mark of interrogation (viewed dorsally), arising anterior to testicular field towards left of body; maximum width 0·137 mm.; maximum length 0·562 mm.; oviduct passing diagonally to right. Vitellarium occupying both lateral fields, beginning 1·022 mm. (0·687) from anterior end of body. Vitelline fields distinct anteriorly, joining posteriorly to testicular field and passing 1·503 mm. (1·562) into cotylophore. Paired vitelline ducts commencing 1·125 mm. from anterior end of body in same region as dorsal suckers and passing 1·06 mm. posteriorly to unite as common vitelline duct, 0·312 mm. long, which joins oviduct. Genito-intestinal canal joining right arm of alimentary canal. Uterus passing posteriorly and then curving forwards as a thin-walled duct to open into atrium. Often as many as six eggs at one time seen in uterus. Eggs oval, with long hooked tail at end opposite to operculum. Egg ·2 mm. wide, 0·575 mm. long, including tail 0·038 mm. long; hook 0·013 mm. long, 0·10 mm. wide (fig. 24).

Generic Diagnosis: **Diplasiocotyle** n. g. Microcotylidae — Body large, symmetrical; mouth aperture subterminal; buccal cavity with two oral suckers. Mid-ventral genital atrium armed with equal-sized small hooks. Conspicuous cotylophore without hooks but bearing several pairs of large suckers with typical skeletal support; also one pair of small suckers at posterior extremity.

Diplasiocotyle is assigned to the Microcotylidae, since it agrees with known members in its general anatomical structure. It probably approaches *Microcotyle* most closely, but differs in the cotylophore, which in the latter genus has numerous small suckers, all of approximately the same size, whereas *Diplasiocotyle* bears suckers of two widely different sizes but the majority are extremely large. Skeletal structures of these suckers differ from the type found in *Microcotyle*. The name of Professor T. Harvey Johnston is associated with the species.

Several Stages in the Life History of Diplasiocotyle johnstoni

A number of specimens of *D. johnstoni* were taken from their host and placed in some small glass dishes containing water from the Swan River at Crawley, which was approximately of the same salinity as sea water. After periods varying from one to several hours, these forms which had been quite inert, recovered and became active. A few of these specimens produced some eggs, laying an average of 25 each, although some produced as many as 60, which, when laid, sank to the bottom of the dish. The parasites lived usually for a period of three days, but some remained alive for four days, during which they were quite active.

In order to hatch the eggs it was found necessary to keep them in sterilized river water at a constant temperature and in an enclosed vessel to prevent evapora-

tion and to ensure a constant salinity. A larval form, almost ready to be hatched, moved quite actively and rotated within the egg by means of cilia (fig. 26 and 27). The operculum was eventually forced open by the movement of the miracidium which, after it had liberated itself, immediately began to swim about quite rapidly (fig. 27). The opening of the operculum required from one to two hours. The eggs hatched within 19 days after having been laid, producing larvae with bodies constricted into three definite regions, each covered with cilia. A cotylophore region is distinctly constricted and bears three pairs of minute hooks set in small projections, as well as two pairs of large median hooks 0·037 mm. long, one pair of which can be protruded from the posterior end of the body. This miracidium has a maximum length of 0·186 mm. including 0·062 mm. occupied by the cotylophore and a maximum width of 0·062 mm. when at its normal length. The eye-spots then are situated 0·062 mm. from the anterior extremity of the body (fig. 28 and 29). The body can be extended considerably, reaching two or three times its normal length (fig. 30). The miracidia move very rapidly by a rotating movement and are usually most numerous round the edges of the container. These larvae continue their movements for two days, at the end of which time their activities are considerably lessened and death soon follows, if the required host has not been reached.

The youngest parasite form (fig. 31) recovered from the gills of the host has a maximum length of only 0·687 mm.; maximum with 0·137 mm. at approximately the anterior end of the genital complex.

The developing cotylophore occupies 0·312 mm. of the total body length and bears altogether four pairs of suckers and two developing suckers. Three pairs of these suckers, those centrally situated are large, those of the middle pair being 0·125 mm. wide, 0·05 mm. long. Posterior to these three pairs is another pair of much smaller suckers, 0·062 mm. wide, 0·05 mm. long. The right side of the cotylophore bears both at its anterior and its posterior ends a small developing sucker. The anterior one of these is 0·062 mm. wide, 0·037 mm. long; while the most posterior one is 0·025 mm. wide, 0·037 mm. long.

The small paired oral suckers have a diameter of 0·037 mm.; no hooks are apparent along the edges. At this stage the genital organs have not become differentiated, though a genital mass is present, occupying the region of the future ovary and testes. This mass has a maximum width of 0·075 mm. and a maximum length of 0·25 mm.

Another immature, but later and more developed stage (fig. 32) in the life history was also obtained from the gills of *Agonostomus forsteri*. Total body length of parasite 1·375 mm. and the maximum width of the body anterior to the cotylophore 0·175 mm., occurring across the middle of the testicular field. The cotylophore, 0·525 mm. long, occupies approximately two-fifths of total body length and measures 0·237 mm. across its anterior border, while the width across its posterior border is 0·162 mm. It bears three pairs of large suckers; the largest is the central pair with a maximum width of 0·137 mm. and a maximum length of 0·112 mm. The most posterior pair have each a maximum width of 0·075 mm. and maximum length of 0·05 mm. Anteriorly to these four pairs of suckers is another pair, 0·087 mm. wide and 0·075 mm. long. The most anterior pair of suckers are in the process of developing, and the larger of these has a maximum width of 0·075 mm. and a length of 0·037 mm.

The oral suckers in the buccal cavity have acquired very small hooks along their edges; each sucker has a maximum width of 0·075 mm. and a maximum length of 0·05 mm. The buccal cavity leads into the pharynx, which is very close to the oral suckers and has a diameter of 0·05 mm. The oesophagus has lateral branches and bifurcates at 0·25 mm. from the anterior end of the body.

The pair of longitudinal arms of the alimentary canal pass backwards and unite immediately behind the testicular field.

By this stage the genital complex has advanced sufficiently for the testes to have become differentiated and individual follicles can be recognised. Each follicle has an average diameter of 0·012 mm. The whole testicular field is 0·25 mm. long. The ovary has not yet become specialised. Leading from the field occupied by the genital organs is a duct, probably the developing vas deferens, which terminates at 0·312 mm. from the anterior end of the body. There are no signs of any genital armature.

Literature

Braun, M. 1879-1893 in Bronn, Klassen u. Ordnungen des Tierreichs, Bd. 4, Abt. i.a., Mionelminthes

Brown, E. M. 1929 Proc. Zool. Soc., London, 67-83

Goto, S. 1894 Journ. Coll. Sci., Tokyo, **8**, 1-273

Goto, S. 1899 Journ. Coll. Sci., Tokyo, **12**, 263-295

Linton, E. 1940 Proc. U.S. Nat. Mus., **88**, 1-172

MacCallum, G. A. 1921 Zoologica, **1**, (6), 135-284

Murray, F. V. 1931 Parasitology, **23**, 492-506

Parona, C., and Perugia, A. 1890 Atti Soc. Ligust. di Sci. Nat. Geogr., Genova, **1**, Fasc. III, 59-70

Sandars, D. F. 1944 Journ. Roy. Soc. Western Australia, 29 (in press)

Woolcock, V. 1936 Parasitology, **28**, 79-91

Yamaguti, S. 1933-1934 Jap. Journ. Zool., **5**, 249-541

Yamaguti, S. 1938 Jap. Journ. Zool., **8**, (1), 15-74

Yamaguti, S. 1939 Jap. Journ. Zool., **9**, (1)